

Chapter 8

Evaluating the Ecological Risk Assessment of Remedial Alternatives

8.1 Introduction

Various types of ERAs may be applied to conduct a screening evaluation of remedial alternatives or a more detailed analysis of a selected alternative. Generally, the Tier I baseline ERA will be sufficient in providing the risk inputs for selection of potential remedial alternatives or corrective measures (including the no-further-action alternative) or the need for procedural changes or engineering controls to minimize short-term risks or residual risks. Scoping of a higher tiered ERA may be necessary for sites requiring implementation of remedial action for a large areal extent and/or multiple years of remediation, and sites with complex ecosystems or trophic levels. Again, early project planning with involvement of expert ecological risk assessors, BTAG/ETAG persons, regulatory agencies, and stakeholders will be the key to avoid overscoping and to identifying the type of ERA most appropriate for specific site conditions.

The baseline ERA methodology presented in Chapters 4 through 7 has focused thus far upon the assessment methodology as appropriate for CERCLA RIs and RCRA RFIs. This methodology serves as the framework for all ERAs. As mentioned earlier, an ERA may also be performed for other aspects of site activities. One aspect discussed in this chapter is the performance of risk assessments to support activities undertaken during the FS or CMS. The two prime objectives of this type of ERA are: (1) the development of remediation goals to be applied to site cleanup, and (2) development of comparative risk assessments between different remedial options. The first type is sometimes performed as a component of the RI, but is distinguished in this chapter because of its use in the development of remedial options. The second type of ERA is not as commonly performed, but it can be useful in distinguishing between potential remedial options. Each type of ERA is discussed individually in the following sections.

8.2 Development of Remediation Levels

Remediation (remedial) levels, which are not synonymous with preliminary remediation goals or PRGs, are media-specific chemical concentrations that are associated with acceptable levels of chemical exposure for the site-specific ecological receptors. Remedial levels, also

referred to as target cleanup levels, are considered along with other factors, such as ARARs, in identifying chemical concentrations to which impacted media may need to be remediated in order to achieve acceptable risk levels.

Remedial levels differ from PRGs in that site-specific factors are considered. PRGs are developed as a screening level tool prior to the performance of an RI or RFI. Conversely, remedial levels are developed from the site-specific baseline risk assessment that was developed during the RI or RFI. Remedial levels are just one element of the weight of evidence the risk assessment can provide to the risk manager to assist in remedial decision-making. Some regulatory agencies recommend including the development of remedial levels as part of the baseline risk assessment in order to assist the risk manager in the remediation decision-making process.

Remedial levels for aquatic systems may be derived by sorting and screening site-specific data on chemical concentration and co-occurring bioeffects in a manner analogous to the derivation of ER-Ls, TELs, and AETs (see Exhibits 7 and 18). Remedial levels may also be derived by performing the baseline risk assessment in reverse by rearranging the terms in the terrestrial or aquatic HQ equations:

$$HQ = \text{dose (terrestrial)} / RTV$$

where

$$DOSE = \frac{\text{chemical concentration (C) x ingestion rate (IR)}}{\text{body weight (BW)}}$$

for aquatic receptors

$$HQ = \frac{\text{concentration in water or sediment (aquatic)}}{RTV}$$

The HQ (or HI) is set equal to an acceptable level (e.g., HQ = 1), the exposure route-specific intake factors developed during the baseline risk assessment are applied, and the chemical concentrations associated with the ingestion factors and HQs (or HI) are calculated. In the baseline risk assessment, hazards for terrestrial receptors are calculated by the following expression (equations are similar for aquatic receptors):

$$\text{Hazard quotient} = C \times (IF_1 + IF_2 + \dots IF_n) \times 1/RTV$$

where

Hazard quotient = the hazard quotient associated with exposure of key receptors to the individual chemical

IF = the pathway-specific ingestion factors, each of which incorporates the intake rate, exposure frequency, exposure duration, body weight, and averaging time for the applicable exposure pathway (i.e., all of the risk equation except chemical concentration and reference toxicity value).

For example

$$IF_1 = \frac{\text{ingestion rate for water}}{\text{key receptor body weight}}$$

$$IF_2 = \frac{\text{ingestion rate for food (fish)} \times \text{BCF}}{\text{key receptor body weight}}$$

RTV = the reference toxicity value

C = the chemical concentration or remedial level associated with the HQ

To develop remedial levels, this equation is rearranged

$$C = \frac{\text{hazard quotient}}{[IF_1 + IF_2 + \dots IF_n] \times 1/RTV}$$

As this equation illustrates, remedial levels are chemical-specific. If more than one chemical is to be remediated at the site, the application of remedial levels developed by this approach can possibly result in residual risks exceeding the target hazard level.

Remedial levels should be based upon all key receptors and all significant exposure pathways assessed in the baseline risk assessment for that medium. However, since the pathways resulting in the highest degree of risk will most greatly influence the remedial level, exposure pathways that have minimal contribution to overall risks can be excluded from the remedial level development with little or no impact.

Exhibits 19 and 20 illustrate the development of remedial levels for a terrestrial receptor and for aquatic-based wildlife receptors, respectively.

8.3 Comparative Risk Assessment of Remedial Alternatives

As part of FS activities, different remedial alternatives are examined from a number of perspectives as part of the selection process. The NCP specifies nine selection criteria to be examined as part of remedial alternative evaluation: (1) protection of human health and the environment, (2) compliance with ARARs, (3) long-term effectiveness and permanence, (4) reduction of toxicity/mobility/volume through treatment, (5) short-term effectiveness, (6) implementability, (7) cost, (8) state acceptance, and (9) community acceptance. RCRA has similar criteria.

For a remedial alternative to be acceptable, it must be protective of the environment as well as human health. However, more than one alternative may meet this (and the remaining criteria). In these instances, an assessment of the long-term residual risks associated with both alternatives can be developed as a tool to assist in selecting an alternative. By comparing the degree to which an alternative reduces potential risks with respect to other factors such as cost, acceptability, and effectiveness, one alternative may be identified preferable. For example, Alternative A may reduce risks to an HI of well below 1, but cost \$5 million to implement; Alternative B may reduce risks to an HI of slightly below 1, but cost only \$1 million to implement. Since both risk (hazard) levels are acceptable in terms of the assessment endpoint, it may be preferable to select Alternative B because of its cost/benefit advantage.

In addition to cost, the reduction of risk offered by the alternative should be examined with respect to the risks estimated in the baseline assessment. If the risk reduction offered is not significant, or does not address the primary risks identified in the baseline assessment, these factors should be considered in the remedy evaluation.

The reduction of risk offered by the alternative should also be examined with respect to the nature of the assessment endpoint or the size of the population affected by the baseline risks or remedial alternative's reduction of risk. Although protection of all key receptors is the primary goal, a modest reduction of risk for large populations of key receptors may be preferable to a large reduction of risk for a small group of key receptors.

The potential risks to be addressed in a comparative risk assessment are those remaining after the implementation and completion-of the remedial alternatives (those potentially incurred during the implementation are discussed in Chapter 9). The calculational methodology for performing the comparative risk assessment is the same as for a baseline risk assessment. The potential exposure pathways and receptors should also be the same as the baseline risk assessment unless exposure pathways have been modified due to habitat removal, for example. The main factor that will change is the chemical concentration to which the key receptors may be exposed.

When developing an estimate of potential exposure point concentrations after remediation, careful consideration must be given to where remediation is to take place and where no action is anticipated. It is not uncommon for remedial actions to focus in some areas of a site, leaving others untouched. Therefore, estimating the potential exposure point concentration is not as simple as assuming

exposure to the remedial level, but to a combination of attaining the remedial level in some locations, being below the remedial level at others, and perhaps exceeding the remedial level in some isolated areas where (for some other valid reason) remediation is not anticipated. The potential risks associated with different combinations of remedial alternatives can be addressed by examining each medium separately, and then combining the associated risks.

8.4 Other Applications of Ecological Risk Assessments

The same approach for development of remedial levels and comparative risk assessments can be applied to the support of RD/RA and the assessment of residual risk. Further discussion of the risks generated during remediation and the screening evaluation process for RD/RA alternatives is presented in Sections 9.2.3.4 through 9.2.3.6.